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Creating Indigenous Technology: Utilization of Local Resources

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Abstract

Saudi Arabia is undertaking economic reforms where it is working towards reducing imports, encouraging manufacturing, and promoting the creation of localized technologies. This provides the Kingdom's private-sector with a unique opportunity for growth and expansion, in an effort to maintain relevance and maximize profits. One possible approach to achieve this is the establishment of indigenously grown research and development centers which utilize local talent and resources. Unfortunately, local talent is not necessarily at the level at which the future economy needs it to be and needs to be cultivated and nurtured with the correct methodology.

This paper outlines a strategy for the development of local talent in the course of business operations and defines the various programs and initiatives that can be executed in the private-sector. It details a framework that companies can follow to mature and develop fresh hires for work in both traditional engineering projects and product development.

Moreover, this paper describes the implementation of the aforementioned strategy and methodology by Rawabi Holding Company in an effort to not only develop innovative solutions and increase revenues, but also stimulate economic growth in Saudi Arabia's evolving environment. It analyzes the efforts taken by the company in order to develop their locally sourced talent in their established research and development group and evaluates the success of the measures taken.

In summary, this paper provides a roadmap proven in the local market for talent development which can be used by the private-sector to benefit companies in transitioning to a more development and manufacturing oriented Saudi Arabia.

Introduction

The economy of Saudi Arabia is among the biggest in the world. The kingdom's economy nearly doubled in size in between 2003 and 2013. Along with this incredible economic growth came a substantial transformation that brought fortune and power to Saudi society. Saudi Arabia's economy was ranked the 27th largest in the world (by GDP) in 2003. Currently, it sits at the 19th position: its 750 billion USD economy falling just below Netherlands' 950 billion USD. (IMF, 2017)

Saudi Arabia's economy can be attributed to it being the world's largest oil producer. 90% of all government revenue is from the oil and gas industry. As oil increased in price to 110 USD per barrel in 2013, the kingdom's economy boomed. All this at a time where most economies worldwide were still trying to recover from the economic recession in 2008. Unfortunately, the oil market is extremely volatile. Crude oil fell to half its value in 2014 and continue to fall till it reached its lowest point in over a decade at 30 USD per barrel in 2016 (Macrotrends, 2018). This put the country's oil dependent economy in peril. Global investment in oil is only increasing. This, paired with disruptive energy sources such as renewable energy and shale oil, means historically unparalleled levels of competition for the Saudi Oil and Gas Industry. The kingdom's industries are required to evolve and adapt to survive.

Other major industries in the kingdom include the mining and metals industry. The country possesses substantial metals and mineral deposits on the western-edge of the peninsula. The industry is currently mostly underdeveloped and contributes to less than 3% of the country's GDP. Another major industry in Saudi Arabia is the petrochemical sector. Saudi Basic Industries Corporation (SABIC) is among the leading chemical companies globally. Manufacturing is another local industry that is immature but has shown great potential in the country.

Vision 2030 and The National Transformation Program.

Saudi Arabia introduced its "Vision 2030" in 2016 as a plan for economic and developmental reform. The aim of this initiative by the country is to reduce its dependence on oil and diversify the economy. As per this plan, the kingdom has started encouraging its mining, petrochemical, manufacturing and other industries in an effort to stimulate growth in them. Part of the vision is the "National Transformation Program" (NTP). The program identified the various goals and targets in economic and development sectors that should be achieved in the country by 2020 and then later the ultimate goals in 2030 to accomplish their vision.

Under the National Transformation Program, the kingdom has started moving towards maximizing local content throughout all sectors and industries. It is attempting to reduce dependence of local industries on imported goods and materials and increase the added value from local content. As part of the effort to increase the competitiveness of locally produced products and services, the kingdom plans to add over 300 billion SAR in value to the local industrial and commercial sectors. Saudi Arabia is targeting to boost the percentage of local total expenditure in the public and private-sectors to 50% in 2020 from the current baseline of 36%. Under King Abdullah City of Science and Technology (KACST), the country aims to have at least 17 establishments developing local content and technologies by 2020 and have a minimum of 125 localized and developed technologies. (NTP, 2017)

To support Vision 2030, Saudi Aramco, the kingdom's national oil and gas company and one of the largest Oil and Gas companies in the world, launched their In-Kingdom Total Value Add (IKTVA) program. Aramco aims to increase long-term economic growth and drive local value creation and economic diversification through the IKTVA program. Using the program, Saudi Aramco prioritizes

local goods and services, local talent and their development, and local research and development. These factors now contribute greatly to awarding of contracts instead of just deciding based on the price. A private-sector company increasing their "IKTVA score" not only raises their potential to do business with Saudi Aramco, but also helps them grow their business in the GCC region. The IKTVA program encourages local companies to develop products and services through utilization of local talent and partnerships, or through international aid, thus making them more competitive in the local market and in turn help to diversify the country's economy. (IKTVA, 2016)

With all these local initiatives and programs, the local manufacturing industry is getting a huge boost. Multiple private companies have started producing locally. This includes international companies such as car manufacturers. Other prospective locally manufactured goods include electronics, and electrical and mechanical machinery. With manufacturing getting localized, the obvious next step for the country is to localize the engineering, research and development (ER&D) of technologies too. KACST is already working on encouraging local R&D and is targeting to increase the number of patents issued in the kingdom by more than 600% by 2020 and improve local talent development to have at least 350 skilled technical experts supporting local content development in the country (NTP, 2017).

Research and Development in the Private-Sector.

With so much focus on the public-sector for expansion, the private-sector will have to develop their engineering and R&D centers and manufacturing capabilities too to stay competitive and relevant. ER&D can help a local manufacturer attain a technical advantage and increase chances of success in the market. Moreover, continuous investment into engineering, research and development helps businesses to innovate and gain new competitive advantages. Engineering and R&D is typically central to a business's vision and objectives. Engineering, Research and Development acts as a driver to the company's progress and helps in achieving better financial outcomes for investors and business owners than their competitors. Additionally, Research and Development projects often get aid from government initiatives, allowing a business to reduce their costs and taxes.

Traditionally, the private-sector has always relied on overseas products and expertise in providing products and services to national projects. With all focus now being put on engineering and R&D for localized and indigenously developed technologies, a massive human resource challenge has been created. There is an urgent need for skilled local engineers and scientists in the country to help stimulate innovation and aid the Saudi industry to build a knowledge-based economy.

The Problem with Locally Available Resources

As mentioned previously, establishment of indigenous engineering, research and development centers in private-sector companies is not only highly advantageous but also encouraged by the kingdom. These R&D centers should utilize local talent and resources. Unfortunately, local talent is not necessarily at the level at which the kingdom's future economy needs it to be. As of 2016, there were only 36,000 individuals in the Saudi labor force who have completed any kind of job training program. Moreover, only 138 Saudis were enrolled in Potential Leadership Development programs in the country. (NTP, 2017)

Even the output of the kingdom's universities and vocational colleges are groomed for traditional desk jobs with innovation and creativity not being fostered in them. Fresh engineering talent is typically extremely egotistical. Many of them have high expectations to hold supervisory posts soon after graduation without considering building the needed skill and experience. They are also usually lacking in behavior, attitude, communications skills, work ethic, adequate exposure to work environments, etc.

These graduates might have the technical knowledge, but they do not necessary know how to use and apply it, or even work in a professional environment. To make things worse, there is an extreme lack of technical development resources available in the country to help train the local workforce. All these factors prevent in moving the industry and economy in the desired direction. Local talent needs to be cultivated and nurtured with the correct methodology for the establishment of these ER&D centers to be possible.

The importance of talent development has been covered previously in literature (Al-Halal, 2017) with some even suggesting in-depth mentorship programs as strategies (Al-Khalifa, 2016). These are insufficient for addressing the need for the Kingdom's future economy. A detailed and in-depth talent development roadmap that would allow for the development of localized technologies is required.

The Talent Development Roadmap

Rawabi Holding Company recognized the onset of the economic pressure climate and the country's National Transformation Strategy for a diversified production base as a timely opportunity to test a new business strategy without theorization and interruption in its services to its most important clients and moved forward with establishing a local research and development department under one of their joint ventures. The strategic direction was aimed at value creation and maximizing the economic earned value from its contracts through a) national managerial expertise with innovation and development inclination, b) proprietary intellectual property, and c) best-in-class, indigenous engineering skills.

The challenge soon became clear in what strategy and methodology the company would put in place for local talent development. Realizing the lack in the availability of local engineers with strong technology application experience, the company determined the need for developing the talent and skills in house. Establishing a multi-disciplined engineering team to undertake technology development and application primarily required current and strong R&D engineering management experience which would orchestrate the engineering operations and achieve the business goals. Developing technologies and designing and building products required current knowledge in science and theory. To acquire the knowledge, it was decided to invest in university students.

Working under the constraint of indigenous engineering resources only, tremendous experience in building technical teams and developing their talents has been accumulated. The two major components in that effort are the engineering management with technical and business acumen and expertise, and a courageous and ambitious engineering team. That experience, thus far, has precipitated a 5-phase roadmap that soon became the framework for local engineering talent development in the company. The local engineering talent development roadmap is a long-term, on-going process with actual development starting from internship but not necessarily ending with young engineering leadership. However, it is a roadmap sufficient for making technologies and building products per client's specific needs. With personal involvement of the engineering manager, the roadmap comprises the phases: Candidate identification (recruitment), Self-worth/talent discovery (internship/co-op), Start-up (full time hiring), Sharpen engineering discipline (junior engineer), Promote engineering leadership (experienced engineer).

Phase I: Candidate Identification.

Candidate identification and selection is atypical where candidates' resumes are screened for technical content and their transcripts analyzed for academic performance and behavior. Points of

academic strength for each candidate should be identified and measured against the skills needed for the available internship projects.

The objective of this phase is to assess candidates against a list of criteria suitable for ER&D undertaking, for technical positioning, and for department culture. Candidates should be assessed and filtered for their talent (high, moderate, or low), ambitions & motivation, knowledge (subject matter tests), inquisitiveness & sharpness, future plans, courage, and their chemistry with the engineering team.

It is worthy of note that standards in the above assessments for local male and female students are not the same due to social code of conduct and university curricula.

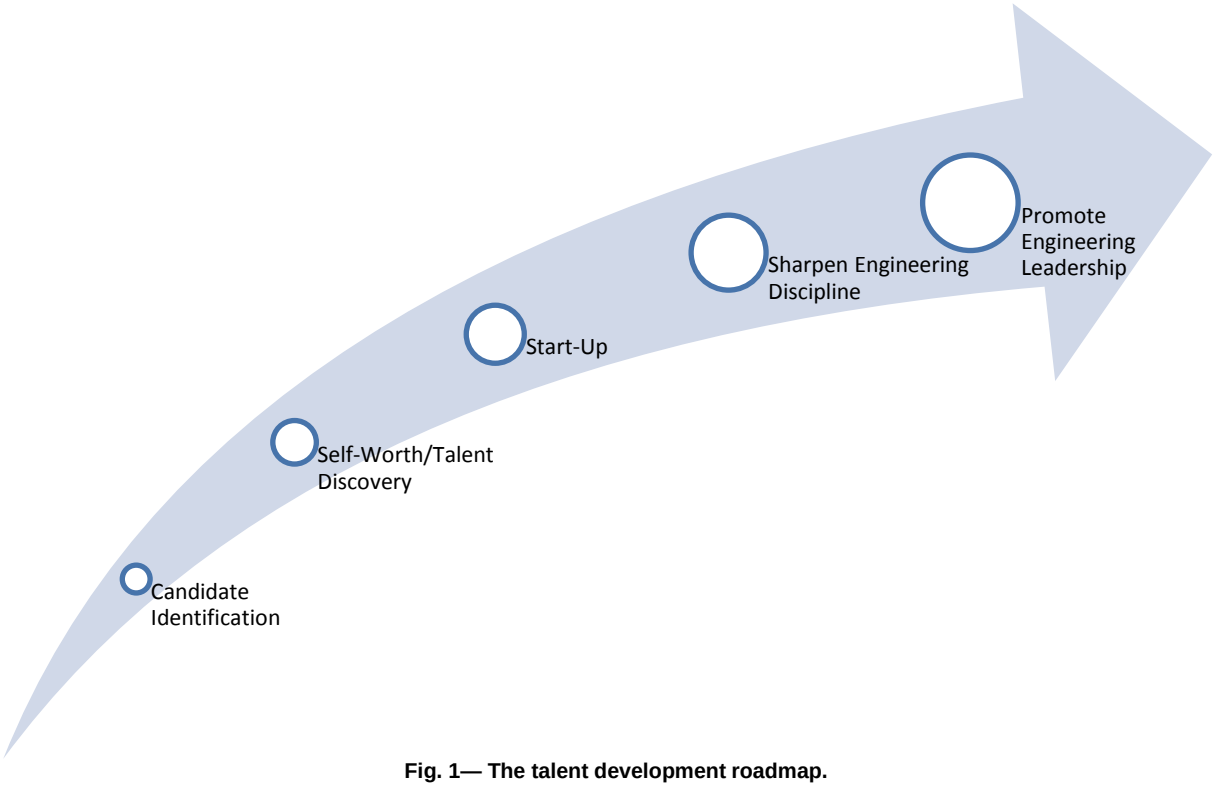

Fig. 1— The talent development roadmap.

Phase II: Self-Worth/Talent Discovery.

Candidates should be accepted into the company's engineering internship program after having passed the stress assessment. Each intern should be supervised by the engineering manager or skilled mentors and assigned an applied research, a design, or development project that, under normal conditions, typically would take several months. However, in internship, they would only have 8 weeks to finish. If it is a 6-month co-op, a major design project should be assigned. Their roles should be academic major related involved directly with active business projects.

The program's immediate objective is to develop the intern's self-confidence by end of the first week. Throughout project execution, the engineering internship program should involve the following:

- Materialization of the intern's own proposal
- Building the engineering attitude and personality
- Training on engineering processes and time-constraint discipline
- Handling high pressure and stress

- Allowing the intern speaking space and freedom
- Motivation through application of points of academic strength
- Attending and participating in weekly engineering meetings
- Attending technical seminars to teach softcore engineering skills
- Rescue (assisting interns to overcome skill deficiency and get back on track)

At the end of the internship program, each intern should be required to present their project to a wide range of company audience. A tremendous transformation is typically observed in the majority of interns during their exit presentation. Interns demonstrate visible self-assuredness, engineering technique skill, pronounced attitude and motivation and breadth of technical knowledge outside their major. Depending on the business needs and on-going projects, some interns could request to continue working with the company part-time beyond their internship/co-op until their graduation to further their engineering experience.

Phase III: Start-Up.

This is a short-duration phase for the interns hired in full-time permanent positions, who demonstrated excellent performance and achievement. Here, the roles are engineering process function related as opposed to academic major as in internship; the objective is job role positioning. Whether hired from the internship program or fresh out of college, nurturing of fresh talent needs individuals to be self-motivated to learn and to train themselves. Therefore, they should be first put on theory application tasks to provide the motivation and anchor the knowledge.

The main theme in the Start-up phase is to prepare the new employee's functional attitude as an engineer prior to integrating him/her into the engineering process and engineering team. It should involve methodical problem analysis and articulation, learning various basic engineering skills, and organizational skill development.

The entry-level engineer soon would demonstrate gains and readiness to participate in large development projects while still learning from his senior counterparts and should be able to manage work at their pace.

Phase IV: Sharpen Engineering Discipline.

This phase is long in duration starting from his/her first year and extending to 4 years at most. It prepares the engineer to add value to the company in ways that generally are not seen in revenue. It concerns building the employee's hardcore and softcore engineering skills and technical foundation.

The engineer should be under direct supervision, mentorship, and coaching of the engineering manager. Participating in design and development projects, the engineer is assigned functional or discipline tasks and is accountable for the deliverables. The engineer is also expected to undertake multi-functional tasks in order to get the project done. This is especially important in organizations not accustomed to engineering operations.

The junior engineer's experience accumulates through on-the-job-training assignments. Over several years, the engineer would be exposed to incrementally complex tasks. He/She would apply problem solving techniques and be capable of resolving issues independently and become proficient in technical communication and reporting. The engineer would also get accustomed to multi-tasking, absorbing high

pressure and coping with stress, and working under strict engineering processes, procedures, and standards. In-house and/or external technical training should be provided to develop his/her softcore engineering skills. The engineer would work on hands-on design and development work and take care of a wide range of organizational responsibilities

It would be observed that in the first year, the engineer begins to demonstrate maturity and independence as well as begin to demonstrate value, not in the sense of direct revenue to the company, when transitioning from internship to full-time hire.

Phase V: Promote Engineering Leadership.

This phase is the experienced engineer phase. The company's business needs naturally demand experienced engineers very quickly to advance technology, lead the competitive edge of the industry, and ramp up project execution. What would take the general industries many years to reach senior engineering levels, with this roadmap would take only three.

In his fourth year, the engineer would have developed depth of knowledge and breadth of experience to handle technical, operational, and organizational work. In this phase, the engineer is sought for consultation by company departments for his increased cross-functional interface and by his peers for his technical acumen. The engineer would have completed at least one product development project from requirements to product launch and should now be able to manage large-scale projects and interface with clients.

Highly independent, the senior engineer should be given wider space for decision-making concerning project execution and resource allocation. Communication skills in this phase vary from technical to business levels. Leadership is mostly notable as the engineer would be assigned mentorship of 2-3 interns every year where his experience and knowledge are shared, and leadership skills fine-tuned.

Reaching this level of maturity is promoted by delegating some of the manager's responsibilities. It is observed that this practice brings forward leadership qualities in some engineers and adds a range of organizational and business capabilities to their skillset. That sample of engineers are those that can take the role of future engineering managers and, so, should be brought under the manager's focus.

With increased responsibilities come associated accountabilities. The engineer's capacity for work load increases as his accountabilities increase vertically and horizontally. The majority of the company's engineering team have demonstrated courage for assuming higher accountabilities, especially accountability for full project execution and delivery. In the 4th year of the roadmap, the engineer should be able to commit to project budget, schedule, and specifications, a product development project of any size.

Training and development of the engineer is an on-going process. The engineering manager would play a guiding role in the development of the experienced engineer. Whether by delegating responsibilities, technical coaching, or direct technical training, an experienced engineering manager is key for the development and growth of the experienced engineer.

The Role of the Engineering Manager.

From a human resources perspective, the experience, skill, and leadership qualities of the engineering manager are central to local talent development as he is the channel of experience and practice for the

young engineers. For the company, criteria for success are the trustworthiness of the engineering manager to keep the company from harm's way.

The manager should not only be experienced, but also emotionally passionate about his profession. In the case of a business, the engineering department cannot exist without an experienced manager. The following are some qualities and attributes the company should look for in qualified engineering management. He or she:

- Needs to be able to connect with his/her employees. He/She should be relatable.
- Should not spoon-feed or micromanage the new hires. The engineers should be given room to be creative and breathe.
- Should prevent his/her staff from failure, protect them from retribution and work diligently to improve staff weaknesses.
- Should be able to freely share his or her knowledge and industrial experience and not be afraid of being replaced.
- Must be able to think strategically and plan ahead.
- Must be passionate about the kingdom's economy and want to make an impact.
- Should be an all-rounded, multi-disciplined engineering professional who is able to connect all engineering disciplines together.
- Should be able to play the role of big brother/sister, teacher, and manager, as the situation requires.

Results from Using this Roadmap in the Saudi Market

Since Rawabi Holding Company, a privately held Saudi company, established an ER&D department under one of its joint ventures, the department has followed, refined, and enjoyed the outcomes of the previously detailed roadmap. With the establishment of this department, the business aims to develop localized technologies to create value, gain a competitive advantage, and maximize their profits, in the local and ever-evolving market.

To develop this ER&D department, the first step for the organization was to find a passionate engineering manager that has experience in product development. Fortunately, they were able to find one within their organization that had previously worked in the western world for multiple R&D centers and has experience developing multiple multi-million-dollar products in his portfolio, while working with multi-disciplinary and multi-cultural teams. This manager, a passionate Saudi national, was looking to pass on his R&D experience onto the local talent in Saudi Arabia and jumped on the opportunity provided by the business.

As described in the roadmap, local engineers with strong technology application experience were needed. Unfortunately, such talent wasn't readily available locally and the business decided to develop the required engineering skills and talent in-house. To obtain talent that had yet to be negatively impacted by the local industry and were still brimming with creativity and untapped technical potential, it was decided to proceed with looking at local universities for interns. Top local universities were considered for their exceptional reputation in the local market and quality output of graduates.

Two students were scouted from the universities for their high ambition, sharpness, and eagerness to prove themselves. They were highly motivated to develop products, were tinkerers by nature, and worked well together. Their respective fields of study were computer and electrical engineering. These

two students were accepted into the internship program under the mentorship of the engineering manager. Together, they were put on an actual real-life development project for an on-going Saudi Aramco project. They would have to design, develop, fabricate, and then deploy a replacement component for an existing system which was currently causing issues in the field. Under normal circumstances, their project could take up to half a year. They were only given 8 weeks for the entire thing.

The interns were taught the product development framework and expected to follow it while maintaining proper documentation. A tight timeline did not mean quality was sacrificial. They had to go from the requirements phase all the way to testing and deployment. They were required to come up with their own solution to the problem at hand and ended up testing multiple methodologies and prototypes till the most feasible one was decided upon. Of course, at the same time, industrial standards had to be followed, which the interns till now had been unfamiliar with. By the end of the internship project, the two were successfully able to deploy the designed and developed product in the field.

During their internship period, the two locally found prospective engineers were able to experience working in a professional environment. A major transformation was observed in both, mainly in terms of their self-confidence and attitude, and their ability to use engineering skills both in and outside their majors. Both interns requested to continue working part-time after their internships. Their requests were granted and soon after, they were hired immediately after they graduated.

After hiring, the talent development candidates were tasked with larger and larger design and development projects, gradually increasing in task and complexity. At the same time, they were pushed to self-develop and refine their skills. They were also assigned various small tasks that would require problem analysis and articulation and apply basic engineering skills and their learnt theory. By performing these tasks, the two hires started learning engineering skills such as failure modes and effects analysis, root cause analysis and more. At the same time, the application of learnt theory from university would further cement the knowledge into their minds.

The above continued for 2-3 years. During this stage, the engineering hard and soft skills were developed by continued guidance from the engineering manager. Soon, the two were able to multi-task and participate in business-wide multi-functional tasks and be held accountable for their deliverables while working under strict engineering processes. In-house and external technical trainings were provided as required for them to obtain necessary skills. A significant improvement was seen in their communication, reporting, and technical writing skills. By the end, the engineers were demonstrating maturity and independence. They had in-depth knowledge and experience to handle technical, operational and organizational work. As they moved further in their development, more fresh engineers were hired and placed on the same development path.

Now the engineers were deemed ready to assume leadership roles. They were assigned and successfully completed their own product development projects with the now growing research and development team while committing to and following fixed budgets, schedules and requirements. The experienced engineers were assigned some of the engineering manager’s duties and took charge of the later hired junior engineers. Of course, their training and development never stops and is an ongoing process. With enough experience under their belt, they will make fine engineering managers themselves.

Since then, the established engineering, research and development department has created a culture of employee growth and talent development. Fresh talent is offered internship opportunities throughout the

year. A continuous internship program has been established. Interns are given seminars and trainings covering a wide variety of topics to stimulate their development. The prospective engineers are put in the line of actual projects with tight schedules and sometimes even on a project's critical path. Often, a larger project with business need is broken into smaller sub-projects which can be assigned to the intern. This allows the talent to work independently and use their creativity to their fullest. Of course, experienced engineers are assigned as mentors to monitor and guide the interns as necessary. Unfortunately, not all interns are able to cope with the pressure and high expectations. Although rare, every now and then an intern will drop out of the program. Since the program's establishment, around 50 interns have passed through and taken advantage of it.

High performing interns are offered positions in the department as the business allows for. As with the previous hires and the now established roadmap, fresh hires are given continuous on-job training and immediate hands-on work. They are immediately familiarized with industry standards required to be followed in product development. Their work is controlled through constant managerial oversight, and creation of SOPs and guidelines to follow. Hires are encouraged to write about their experiences to help guide future talent and their development. They document their learnt lessons and write white papers on a wide variety of technical topics. This ensure that knowledge and experience is passed on within the business and not lost with outgoing employees.

Lack of locally available technical development resources has been a major challenge in the path of talent development. For this reason, engineers are encouraged to self-develop their skills using whatever resources are available. The obtained skills get refined and tested with them having to be used immediately in on-going technology development projects. This requires high dedication on the talents' part. For example, two skills that have been developed internally are RF (Radio Frequency) Studies and PCB Design. When the ER&D department was first established, these had to be outsourced to external firms. Now they are fully conducted internally. Even non-engineering skills such as financial analysis have been added to the engineers' repertoire as per business need.

The development of talent is not only limited to inside the organization. It can be and has been expanded to universities and colleges. Collaborative projects with universities are regularly conducted by the ER&D department. Additionally, students are offered the opportunity of working on a sponsored senior design project. Both these options help the students to develop themselves before entering the industry. By interacting with skilled and experienced engineers, students get an early introduction to the professional world. Furthermore, seminars are given by the engineering at student and professional organizations to relay their experience and spread knowledge, develop the youth, and spread awareness of the need of localized technologies for Saudi Arabia.

The results of the described talent development roadmap can be seen in the success of the established ER&D department and the number of localized technologies the business now possesses. The department in now capable in a variety of engineering disciplines ranging from electronics, computer/software, and embedded system to mechanical, thermodynamics, and fluid mechanics. One to two products are added to the R&D's portfolio each year. Some of them include a wireless telemetry network, a SCADA system, RTU controllers, and wireless sensors. The output of the R&D demonstrates that the described roadmap can be used to bridge the talent gap present in the local environment and be used to overcome the talent development challenges presented in the Saudi market.

Conclusion

Saudi Arabia's changing economy dictates the private-sector take initiative to align themselves with the Kingdom's Vision 2030 and evolve to survive. Establishment of local engineering, research and development center are mandatory for the sector to stay competitive and relevant. These indigenous ER&D centers are required to develop localized technologies in the kingdom to provide a competitive advantage and maximize profits. The biggest challenge in doing so is a human resource one where local talent is not up to par and needs to be developed and matured.

This nurturing and development of talent can be done through a five-stage roadmap which involves filtering of candidates into internship programs where the engineers are placed on real-life projects and tasks. High performing candidates from there can be hired full-time and be developed till they are capable of leading product development projects and possess the required knowledge and experience to handle any required technical, operational, and organizational work in these Engineering and R&D centers. This roadmap targets to accomplish, what is equivalent to ten years of talent development condensed within approximately 5 years. Of course, this requires the presence and guidance of an experienced and passionate engineering manager to lead and mentor the talent.

Proof of the legitimacy of this roadmap can be seen in results from Rawabi Holding company implementing it in one of their joint ventures to create an engineering, research and development department to create indigenous technologies. The department bringing 1-2 newly and locally developed products per year to the Saudi market is a big step towards the Kingdom's target of achieving 125 localized technologies by 2020. This achievement show that R&D success is indeed possible in the local region by utilization of the provided roadmap. Any developed talent will go and further spread industrial change as they move on. Today's workers and engineers will tomorrow be the leaders and manager guiding the new generation of newcomers in the industry.

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